

Claims

[c1] What is claimed is:

1. A light emitting diode comprising:

an insulating substrate;

a semiconductor multilayer positioned on the insulating substrate, the semiconductor multilayer comprising a first surface and a second surface, a distance between the first surface and the insulating substrate is greater than a distance between the second surface and the insulating substrate;

a first transparent ohmic contact electrode positioned on the first surface; and a second transparent ohmic contact electrode positioned on the second surface; wherein the first transparent ohmic contact electrode and the second transparent ohmic contact electrode comprise the same materials.

[c2] 2. The light emitting diode of claim 1 wherein the insulating substrate comprises sapphire.

[c3] 3. The light emitting diode of claim 1 wherein the first transparent ohmic contact electrode and the second transparent ohmic contact electrode are made of at least one selected from a group comprising indium tin oxide (ITO), cadmium tin oxide (CTO), and titanium-tungsten nitride (TiWN).

[c4] 4. A light emitting diode comprising an insulating substrate, an n-type or n⁺-type contact layer of gallium nitride (GaN)-based compounds positioned on the insulating substrate, and a transparent ohmic contact electrode positioned on the contact layer, the transparent ohmic contact electrode being made of at least one selected from a group comprising indium tin oxide, cadmium tin oxide, and titanium-tungsten nitride.

[c5] 5. A light emitting diode comprising:

an insulating substrate;

a buffer layer positioned on the insulating substrate;

an n⁺-type contact layer positioned on the buffer layer, the contact layer comprising a first surface and a second surface;

an n-type cladding layer positioned on the first surface of the n⁺-type contact layer;

a light-emitting layer positioned on the n-type cladding layer;
a p-type cladding layer positioned on the light-emitting layer;
a p-type contact layer positioned on the p-type cladding layer;
an n⁺-type reverse-tunneling layer positioned on the p-type contact layer;
a p-type transparent ohmic contact electrode positioned on the n⁺-type reverse-tunneling layer; and
an n-type transparent ohmic contact electrode positioned on the second surface of the n⁺-type contact layer;
wherein the p-type transparent ohmic contact electrode and the n-type transparent ohmic contact electrode comprise the same materials.

[c6] 6.The light emitting diode of claim 5 wherein the insulating substrate comprises sapphire.

[c7] 7.The light emitting diode of claim 5 wherein the p-type transparent ohmic contact electrode and the n-type transparent ohmic contact electrode are made of at least one selected from a group comprising indium tin oxide, cadmium tin oxide, and titanium-tungsten nitride.

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